

# LANXESS

Energizing Chemistry

**LEVAPREN®**

Ethylene Vinyl Acetate (EVM)

**The cost-effective specialty rubber**

Edition 2010-10





**LEVAPREN®**

**FOR DEMANDING APPLICATIONS**

**We have tomorrow's requirements in mind**

As a global leader in the synthetic rubber industry, LANXESS offers its customers a comprehensive range of synthetic rubber products, with specialties such as Levapren® playing an important role. Wherever conventional polymers come up against their limits, Levapren®, a polymer with very good heat and weathering resistance, may represent a suitable alternative. The Levapren® product range consists of rubbers that can cope with the continuously more demanding requirements of the following sectors:

- **automotive**
- **machinery**
- **building / construction**
- **wire and cable**
- **sporting goods**

The aim of this brochure is to give a first impression of Levapren®, providing information on its many properties and advantages, and showing both processors and end users possible applications and solutions based on Levapren®. Our experts will be glad to provide you with further technical information. Please find their contact data on page 22 of this brochure.

You may also use our e-mail address at: [info@levapren.com](mailto:info@levapren.com)

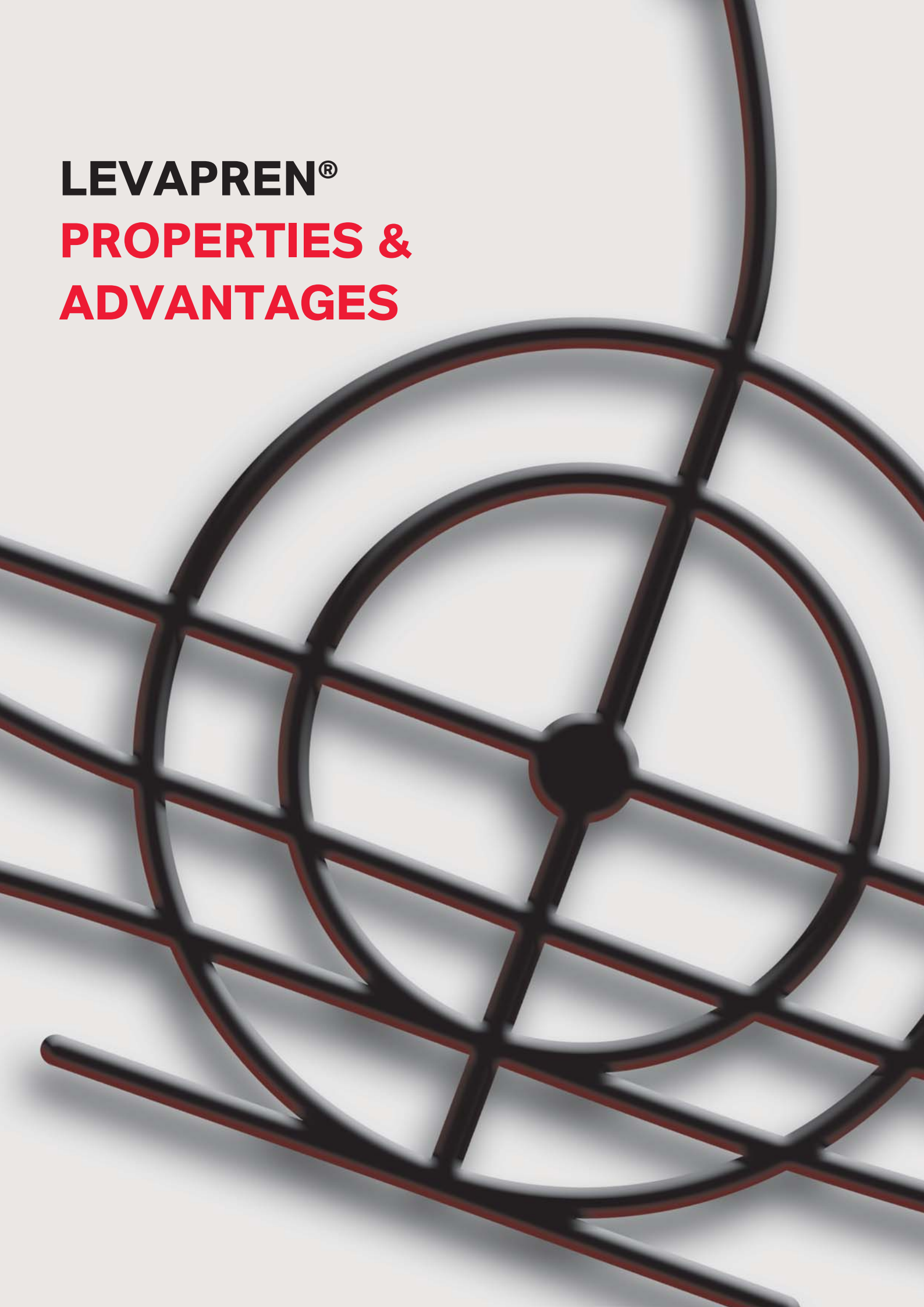
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← Floorings made of Levapren®

Pictures on frontpage:  
 Levapren® based Firehoses  
 Low viscosity provides easy processing for injection molding  
 High flame resistance of Levapren®-sheeted cables

**LEVAPREN®**

**PROPERTIES &  
ADVANTAGES**



# LEVAPREN® SUPERIOR IN MANY DISCIPLINES

## Comparison with other elastomers

A direct comparison reveals the superiority of Levapren® to other elastomers and materials in several disciplines, including cost efficiency.

### AEM

Levapren® is superior to AEM (ethylene-acrylic elastomer) due to:

- better scorch safety
- no post-curing needed
- less odor
- less harmful crosslinking system

### ACM

Levapren® is superior to ACM (acrylate elastomer) due to:

- better scorch safety
- mechanical properties
- better flow behavior
- higher filler acceptance

### ECO/CO

Levapren® is superior to ECO/CO (epichlorohydrin) due to:

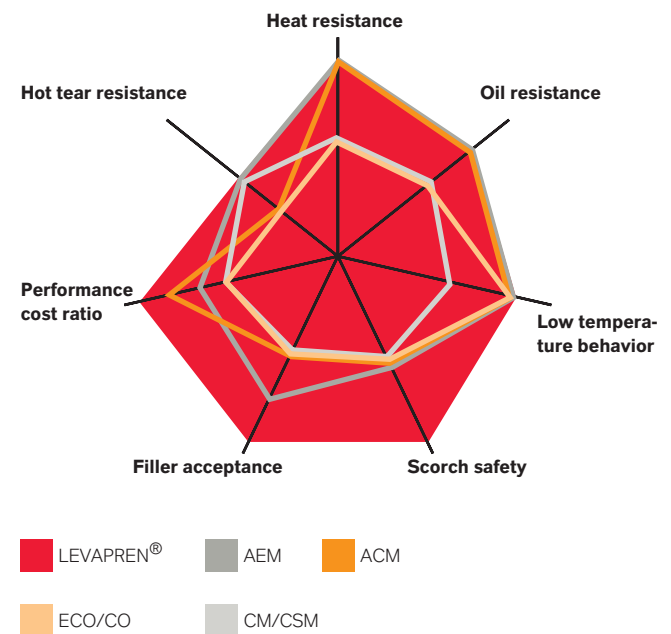
- better heat resistance
- better scorch resistance
- being halogen-free
- better corrosion resistance
- lead-free crosslinking system

### CM/CSM

Levapren® is superior to CM/CSM (chlorinated/chlorosulfonated polyethylene) due to:

- better heat resistance
- better low temperature flexibility
- being halogen-free
- better corrosion resistance

Figure 1: Evaluation of Levapren® properties\*\*\*



\*\*\*See page 23

# PRODUCT PROPERTIES

## Polymer properties

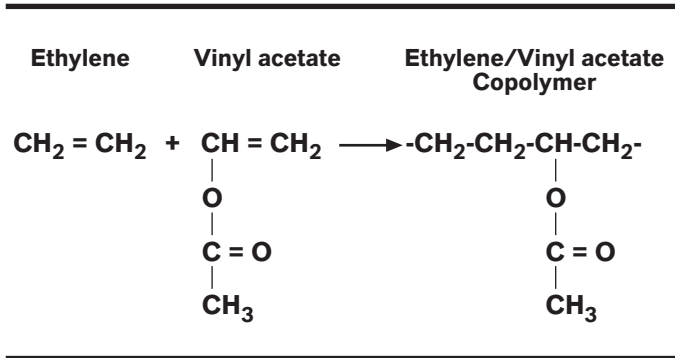
Levapren® is formed by copolymerization of ethylene and vinyl acetate. In principle Levamelt® consists of methylene units forming a saturated polymer backbone with pendant acetate groups. These rubber-like polymers are designated "EVM"1 according to ISO 1629: 1995 (E) nomenclature. The presence of a fully saturated main chain is an indication that Levapren® is a particularly stable polymer. Degradation generally only occurs at very high temperatures and even then very slowly.

The polymers are used as synthetic rubbers, as adhesive raw materials or as modifiers in thermoplastics, specifically PVC. The adhesive raw materials are sold under the brand name Levamelt®, while powdered grades are distributed under the brand of Baymod® L.

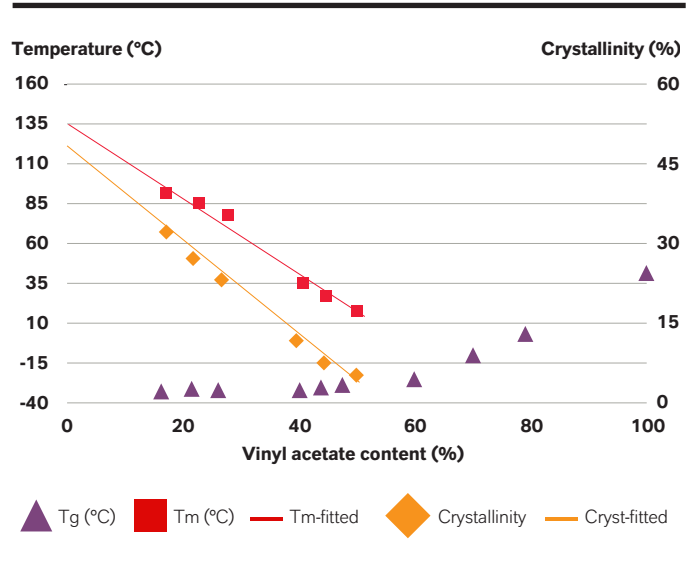
The main differences between the grades are in the vinyl acetate content and the polymer viscosity.

The general property profile of the copolymers produced from ethylene and vinyl acetate is determined in the first instance by the ratio of the two components. The reactivity of the two monomers is so similar that they are statistically distributed throughout the polymer chain, this being ideal for rubber applications.

**Table 1: Chemical structure of Levapren®**



**Figure 2: Influence of VA content on morphology**



The higher the proportion of vinyl acetate in the copolymer, the stronger the regularity of the ethylene chain is interrupted. Crystallization is increasingly hampered and becoming entirely absent at a vinyl acetate content of approx. 55 %. Hence copolymers with a high vinyl acetate content are amorphous.

<sup>(1)</sup> In accordance with ISO 1043-1: 1987, the abbreviation E/VAC is to be used for thermoplastics. The abbreviation EVA is also frequently used.

As a result of vulcanization – a three-dimensional crosslinking of the polymers – the raw compound is converted from the thermo-plastic, viscous state to the elastic state.

Table 2 compares the physical properties of Levapren<sup>®</sup> vulcanizates with those of other elastomers. The property profile obtained is greatly influenced by the composition of the rubber compound and its processing. Generally speaking, the maximum values cannot all be achieved simultaneously.

**Table 2: Typical properties of Levapren<sup>®</sup> vulcanizates compared with other elastomers**

	<b>Levapren<sup>®</sup></b>	<b>AEM</b>	<b>ACM</b>	<b>ECO/CO</b>	<b>CM/CSM</b>
Tensile strength (MPa)	up to 24	up to 20	up to 18	up to 15	up to 20
Hardness (Shore A)	50-90	50-90	50-90	50-90	50-90
Abrasion resistance	B	B	B	C	A
Tear propagation resistance	C	C	C	C	C
Rebound resilience	A-D	C	C	C	C
Hot air resistance; temperature limit under long-term stress, 1,000 hrs (°C)	175	175	175	135	135
Low temperature resistance	C	C	D	C	D
Weathering and ozone resistance	A	A	A	A	A-B
Combustion behavior	A	A-B	C	D	D

A: Excellent, B: Very good, C: Good, D: Moderate

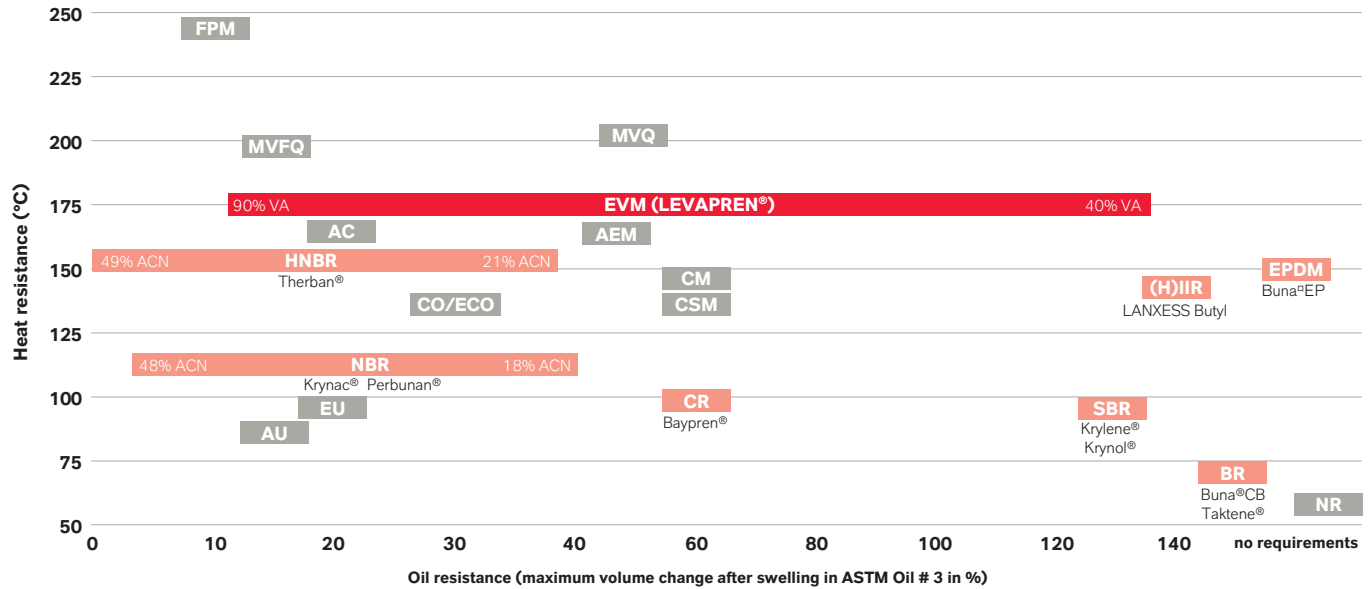
Torsional vibration damper



# VULCANIZATE PROPERTIES

## Hot air and oil resistance

**Figure 4: Classification of elastomers based on their hot air and oil resistance (in accordance with ASTM D 2000/SAE J 200)**



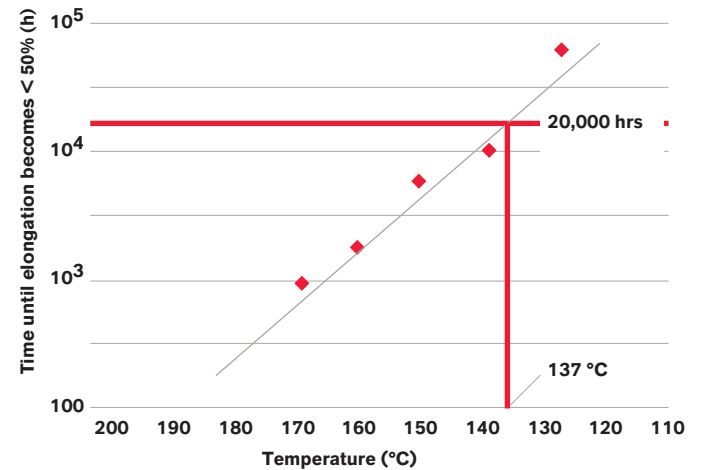
If properly compounded Levapren® vulcanizates display excellent aging resistance and also continue to function over extended periods of stress at elevated temperatures. The heat resistance of Levapren® vulcanizates is considerably better compared to most of other common elastomers.

The very good heat resistance is surpassed only by silicone rubber and fluoro rubber and is equivalent to that of acrylate rubber.

Figure 4 based on ASTM D 2000/SAE J 200 shows how Levapren® can be classified in relation to other polymers. At 40 to 90% vinyl acetate content, Levapren® covers the range from low to very good oil resistance.

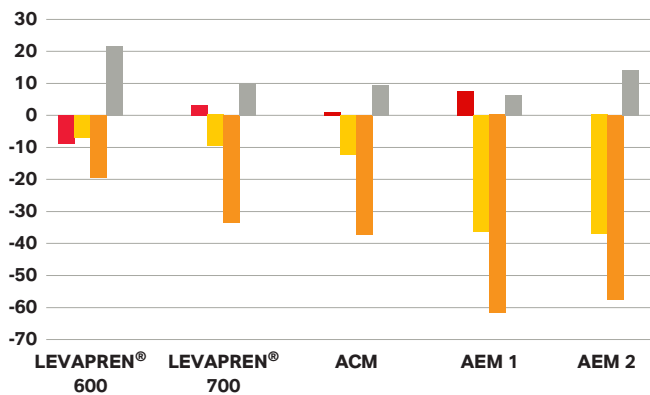
Well protected Levapren® vulcanizates can serve up to 1,000 hrs at 175 °C. Even over a period of 20,000 hrs Levapren® can withstand temperatures of 137 °C according to VDE 0304/IEC 216 (Figure 5).

**Figure 5: Determination of heat resistance of Levapren® (in accordance with VDE 0304)**

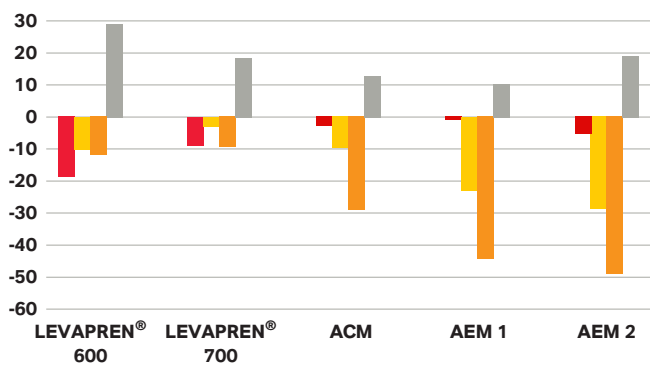


Figures 6 to 8 show the oil resistance of Levapren® 600 and Levapren® 700 vulcanizates compared to commonly used elastomers in the automotive sector. These tests have been conducted in actually applied oils and therefore reflect the performance which can be achieved under real conditions. Although volume change and hardness reduction are slightly higher compared to the competitive products, the change of physical properties like elongation and especially tensile strength are superior to the other tested elastomers.

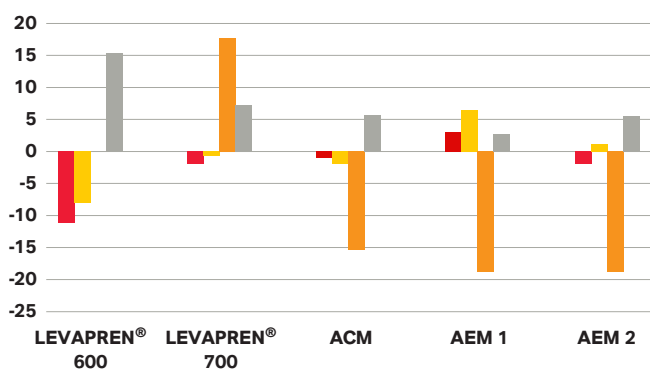
**Figure 6: Physical properties of elastomers after immersion in Engine Oil Helix 5W30 (1008h at 150 °C)**



**Figure 7: Physical properties of elastomers after immersion in Engine Oil Cecilia 20 (1008h at 150 °C)**



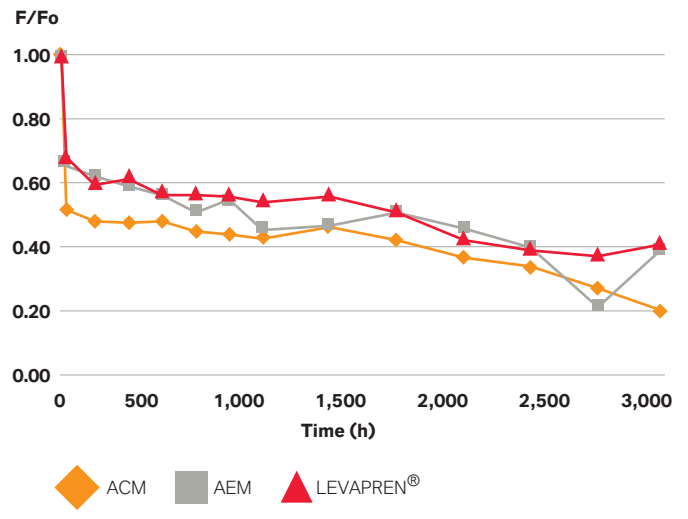
**Figure 8: Physical properties of elastomers after immersion in ATF Gear Oil M 1375.4 (504h at 130 °C)**



■ Chg. Hard. Shore A (pts.)    ■ Chg. Ulti. Tens. (%)  
■ Chg. Ulti. Elong. (%)    ■ Vol. Change (%)

As a higher swelling in oil might even be beneficial for sealing applications, only a more practical test like the CSR method (compressive stress relaxation) is able to determine the sealing force of the vulcanizate. Figure 9 shows the development of the sealing force up to 3,000 hrs.

**Figure 9: Compressive stress relaxation at 150 °C in SF 105G (Dyneon jigs)**



Levapren<sup>®</sup> shows a superior sealing performance in comparison to the benchmarked materials. This makes Levapren<sup>®</sup> a material of choice for gaskets and seals used in a high temperature environment.

Another big advantage for Levapren<sup>®</sup> in sealing applications is the excellent processability, which will be shown later in this brochure.<sup>(1)</sup>

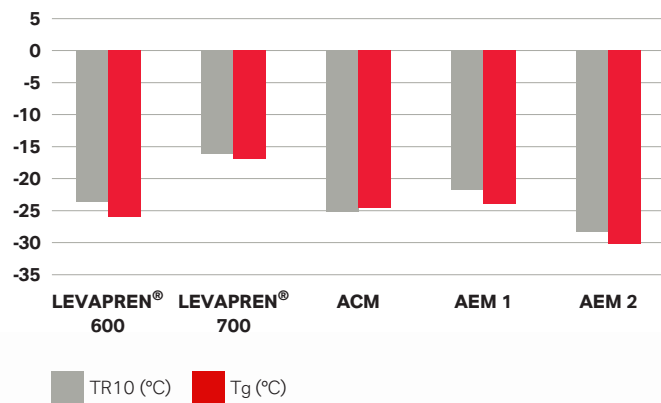
<sup>(1)</sup> See page 14

# VULCANIZATE PROPERTIES

## Low temperature performance

The low temperature performance of Levapren® depends significantly on the VA content. Decreasing VA contents result in a lower T<sub>g</sub> (See also Figure 2). Depending on the application, the broad range of our Levapren® portfolio offers the possibility to select the right grade for the optimized solution regarding low temperature and oil resistance.

**Figure 10: TR10 & T<sub>g</sub> (measured by DMA) of representative vulcanizates**



# VULCANIZATE PROPERTIES

## Halogen-free and FRNC (Flame Retardant Non Corrosive)

Levapren<sup>®</sup> is the material of choice wherever flame retardance has to be achieved. It presents the additional advantages of being halogen-free and of burning with non-corrosive emissions. Flame retardancy is achieved by adding high amounts of specialized fillers, such as aluminium hydroxide or magnesium hydroxide.

Based on small-scale laboratory flame tests, properly compounded Levapren<sup>®</sup> displays lower smoke evolution than competitive materials. Smoke evolution during an actual fire may impair visibility and obscure escape routes. By proper compounding FRNC materials complying even with DIN 4102/Fire Class B1 can be produced.<sup>(1)</sup>



Figure 11: Flame-retardant and chlorine-free fuel hose cover made of Levapren<sup>®</sup> by Veritas\*\*

FRNC materials are particularly suitable for use in heavily frequented areas such as:

- department stores
- hospitals
- airports
- railway stations
- buses and trains, especially underground trains

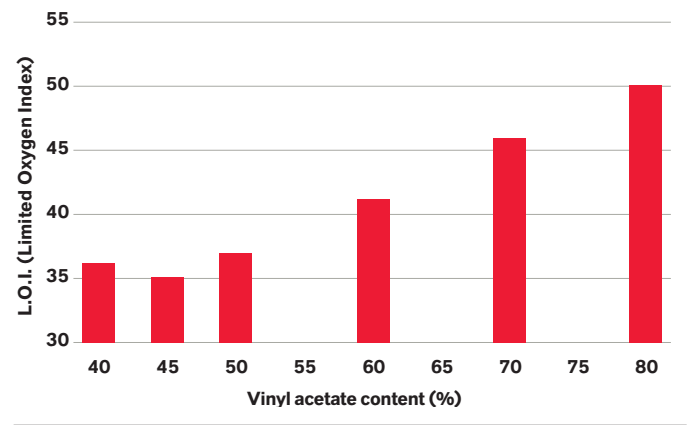
and in buildings which contain high-value equipment and articles:

- computer centers
- museums

What's more, disposal of old halogen-free rubber products has less of an environmental impact.

The flame-retardant properties of Levapren<sup>®</sup> vulcanizates are not only affected by the amount and kind of filler in the compound, but also by the vinyl acetate content of the EVM grade used (see Figure 12). The higher the content of the vinyl acetate, the higher the limited oxygen index (LOI) of the resulting material and therefore the lower the flammability.

**Figure 12: Effect of the VA content/Aluminium hydroxide (ATH 190 phr) on the L.O.I. (in accordance with ASTM D 2663)**



<sup>(1)</sup> Proper compounding assumed, flammability results are based on small-scale laboratory tests for purposes of relative comparison and are not intended to reflect the hazards presented by this or any other material under actual fire conditions.

\*\*See page 23

# VULCANIZATE PROPERTIES

## Weathering, UV and ozone resistance

Environmental factors can significantly reduce the properties of elastomers, with ozone, UV radiation, rain and industrial waste gases proving particularly damaging. The effects are described according to their appearance as ozone cracking, crazing (non-oriented tear cracking), chalking, softening or hardening. Vulcanizates with light-colored fillers in particular are sensitive to these influences.

Levapren® vulcanizates show none of these effects after outdoor weathering tests conducted over 2-year periods. The samples were still usable at the end of the trial.

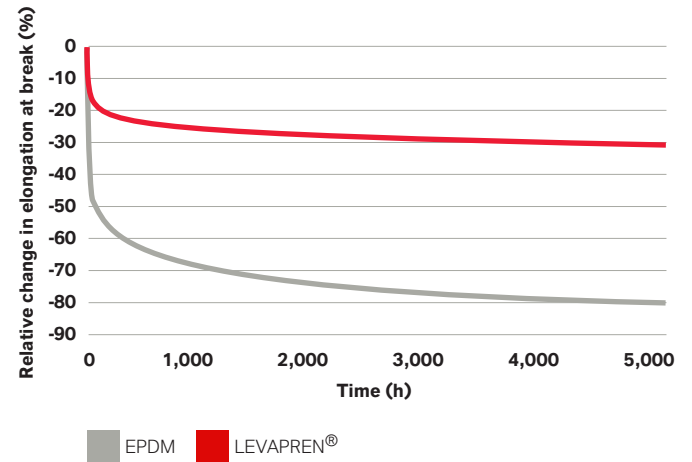
Similar positive results were obtained in the laboratory after trials involving UV radiation in a xenon tester.

A light-colored Levapren®-based FRNC (Flame Retardant Non Corrosive) compound was protected with 10 phr titanium dioxide and 1 phr UV stabilizer. The changes in elongation at break are depicted in Figure 14 and are compared with the values obtained from a similar compound based on EPDM showing a clear advantage for Levapren®.



Figure 13: Colored profiles made of Levapren®

Figure 14: Xenon Test DIN 53387: Relative change of elongation at break (%)

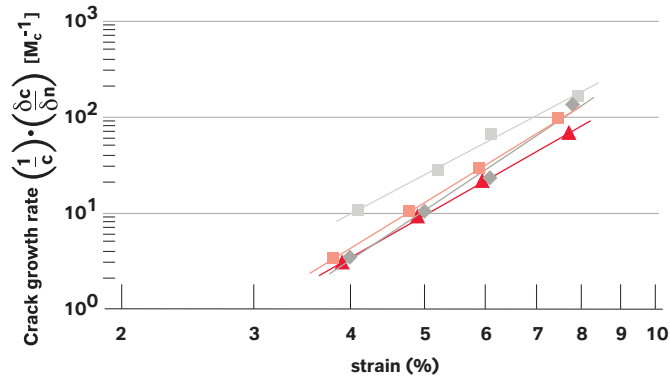


# VULCANIZATE PROPERTIES

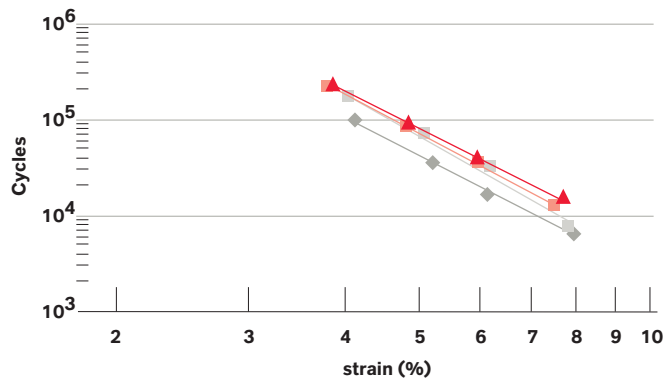
## Mechanical and dynamic mechanical properties

Compared to AEM, Levapren® shows superior tear propagation resistance making it an ideal material for dynamic applications under severe environmental conditions.\*\*

**Figure 15a: Dynamic crack growth rate of Levapren® and other elastomers measured by tear analyzer at 80 °C in unaged and aged condition (aging: 7 days at 170 °C)**



**Figure 15b: Lifetime of Levapren® and other elastomers measured by tear analyzer at 80 °C in unaged and aged condition (aging: 7 days at 170 °C)**

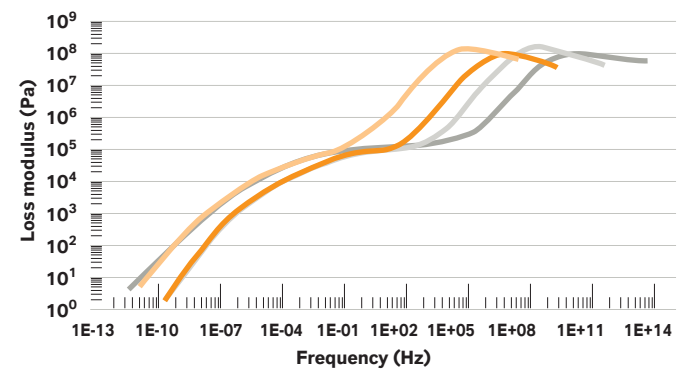


AEM 1   
  AEM 1 aged  
 LEVAPREN® 700   
  LEVAPREN® 700 aged

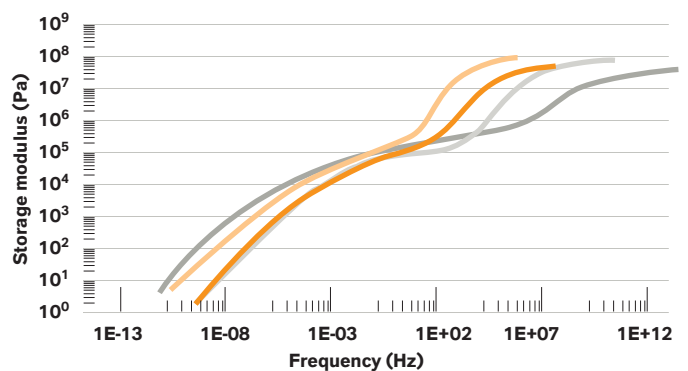
The high VA content Levapren® grade (Levapren® 800 and Levapren® 900) provide high damping at room temperature whereas the low VA content grades (Levapren® 400 and Levapren® 500) show an extremely elastic behavior. This can be seen in Figures 16a and 16b.

Different Levapren® grades can be blended together, thus delivering an elegant way to produce materials with tailor-made dynamic mechanical properties.

**Figure 16a: Frequency dependence of the complex shear modulus at 20 °C of raw polymers (Mettler DMA/STDA861e and Rheometer Physica MCR300)**



**Figure 16b: Frequency dependence of the complex shear modulus at 20 °C of raw polymers (Mettler DMA/STDA861e and Rheometer Physica MCR300)**



LEVAPREN® 400   
  LEVAPREN® 500  
 LEVAPREN® 800   
  LEVAPREN® 900

\*\*See page 23

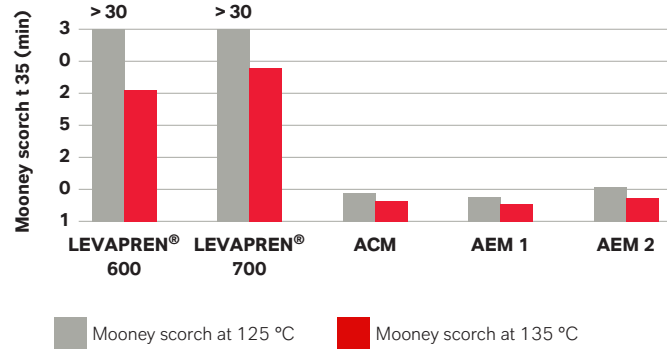
# COMPOUND PROPERTIES

## Processability

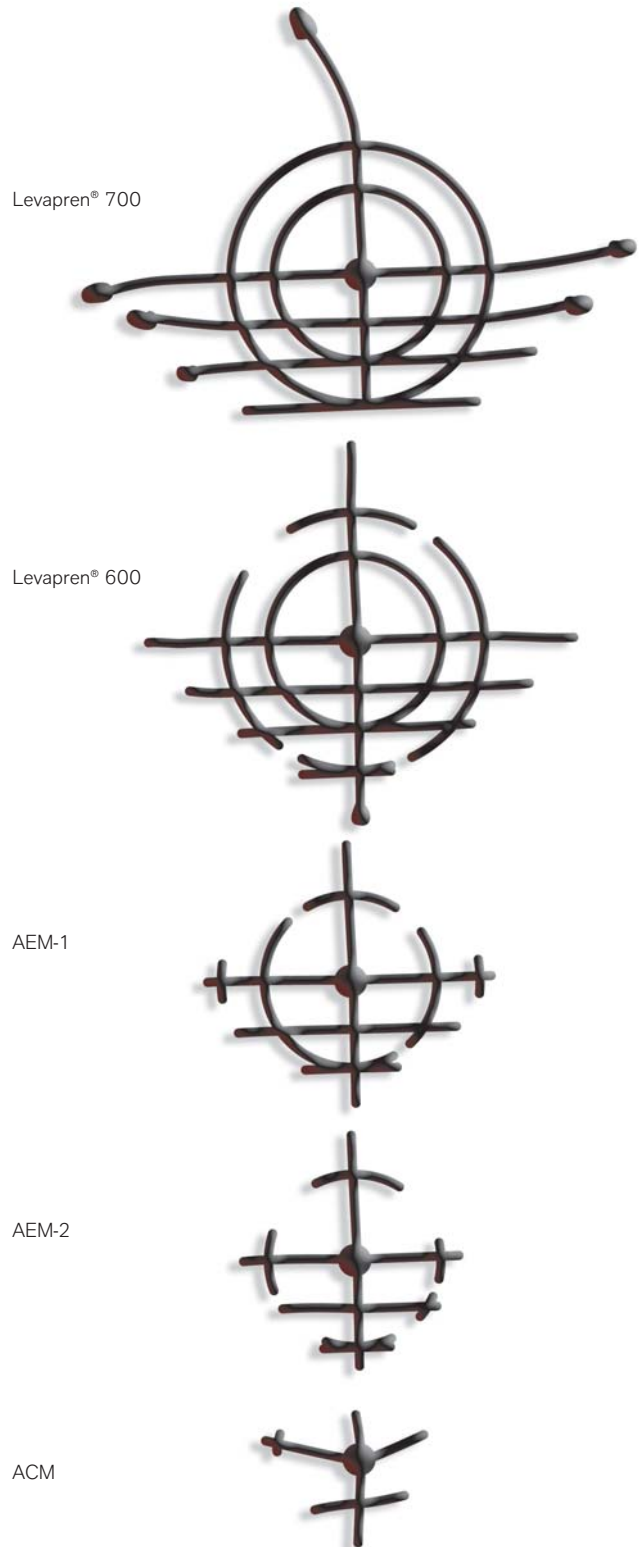
All Levapren® grades are delivered as granules, allowing the material to be fed and therefore mixed continuously.

The low viscosity of Levapren® results in excellent flow properties which, combined with a very high scorch safety of Levapren® compounds (see Figure 17), enables the rubber manufacturer to produce highly sophisticated injection molded parts (see Figure 18). Post-curing is not necessary, though for certain applications or technical reasons it can be applied.

**Figure 17: Scorch safety**



**Figure 18: Filling level of injection molded parts at 180 °C mold temperature, 50 bar injection pressure and 15 sec. injection time**

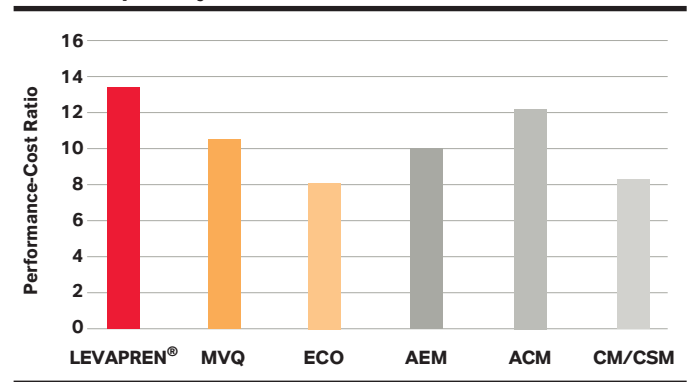


The combination of properties of Levapren<sup>®</sup> with respect to:

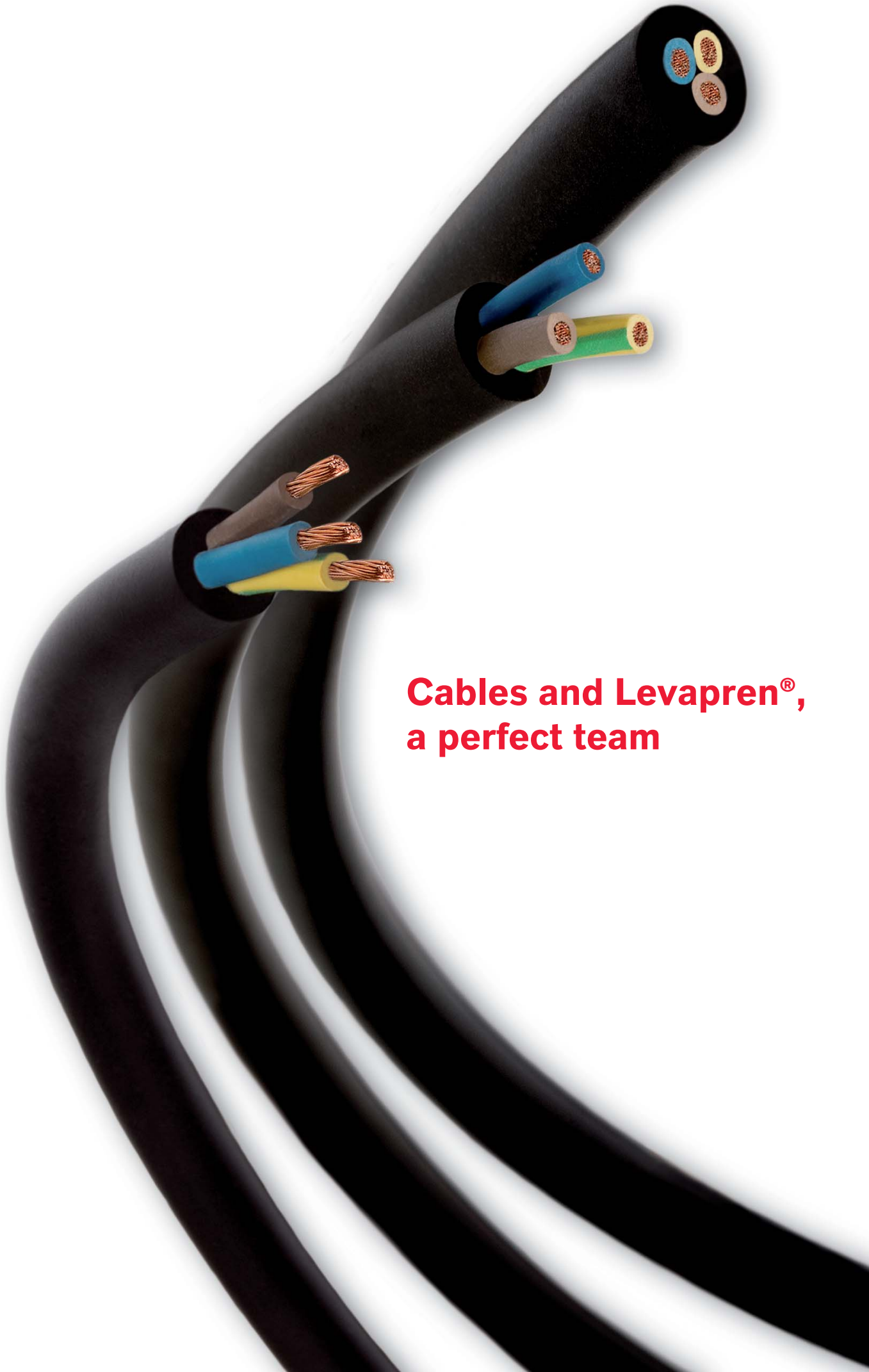
- high temperature resistance
- low temperature resistance
- oil resistance
- weather and ozone stability
- being halogen-free
- processability

offers the best performance cost ratio within the range of specialty elastomers.

**Figure 19: Performance Cost Ratio of Levapren<sup>®</sup> compared to other specialty elastomers<sup>(1)</sup>**



<sup>(1)</sup> Performance based on oil resistance, high temperature and low temperature properties. Cost based on typical compound compositions in EUR/liter (Source: LANXESS customer intelligence).



**Cables and Levapren<sup>®</sup>,  
a perfect team**

## Seals

Due to its long-term heat stability and its good resistance to automotive fluids, Levapren® is used in seals, e.g., for rocker head covers.\*\*

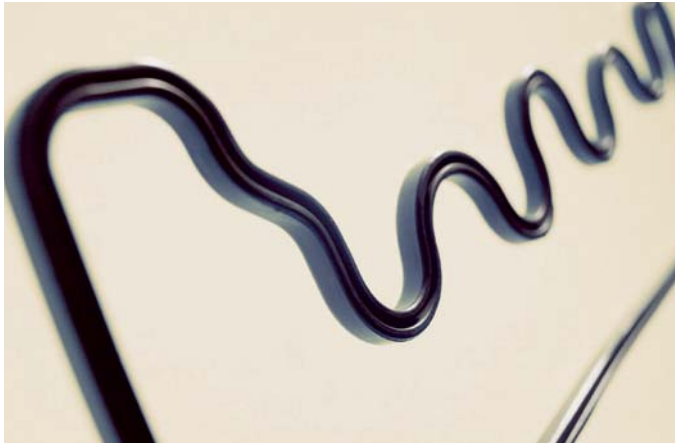


Figure 20: Rocker head cover seal based on Levapren®

## Foams

Interep produces sponges out of Levapren® which are formulated for more favorable combustion behavior than competitive materials. These sponges are used in many applications where human safety has highest priority or where significant material assets exist. Typical applications are in ships, railways and buses.\*\*



Figure 21: Levapren® sponge with more favorable combustion behavior

## Hoses

Levapren® is used as base material for flame-retardant and chlorine-free hose covers like in the fuel hoses for AUDI produced by Veritas.\*\*



Figure 22: At home under the hood: fuel hose cover made of high-performance EVM Levapren®

## Floor coverings

Floorings based on Levapren® can not only fulfill FRNC requirements<sup>(1)</sup>, they also give benefits like good resistance to wear, abrasion, ozone, weathering and they offer outstanding color stability.\*\*

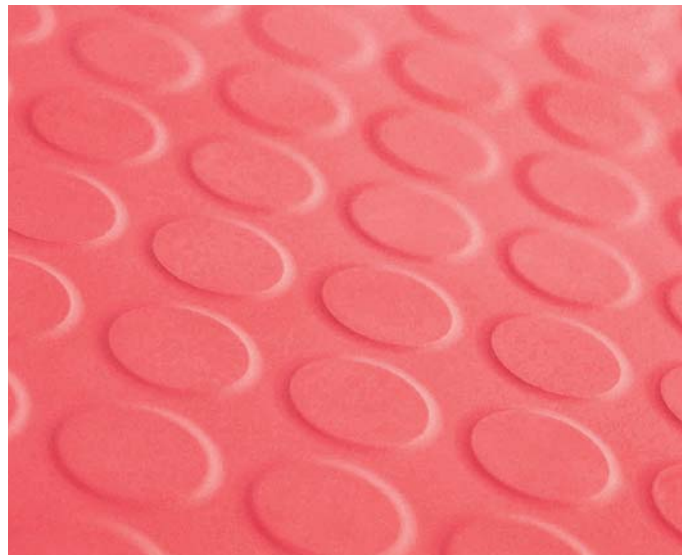


Figure 23: Floor coverings made of Levapren®

<sup>(1)</sup>Proper compounding assumed, flammability results are based on small-scale laboratory tests for purposes of relative comparison and are not intended to reflect the hazards presented by this or any other material under actual fire conditions.

\*\*See page 23

# APPLICATIONS OF LEVAPREN®

## Sensor cables

Due to its polymerization process, Levapren® molecular weight is particularly widely distributed. That is why it is a gel-free product, which has a positive effect on the processability of the material and the quality of the end product such as the sensor cables produced by Facab Lynen. Gel particles would impact the function of the cables and therefore cause safety problems.

For instance, Levapren® vulcanizates satisfy the stringent requirements of such applications in terms of thermal stability, flame retardancy, and good resistancy to ozone, UV light and industrial waste gases.\*\*



Figure 24: Sensor cables produced by Facab Lynen

## Cables

Due to the high flame retardancy and the heat and fluid resistance of FRNC Levapren® vulcanizates, cables are one of the key applications of Levapren®. Many cables in buildings, ships and mass transit or rolling stock are made of FRNC Levapren® compounds.\*\*

## Vitroflex®<sup>(1)</sup>

Flexibility in design without compromising on properties is one of the common challenges in the industry. Levapren® enables designers to create translucent articles with very good weather and UV resistance which in most cases can only be achieved with carbon-black-filled rubber articles. Reinforced with glass fibers, this material, called Vitroflex®, is used, for example, for the flex bellows in busses, allowing more light to pass inside.\*\*



Figure 25: FRNC Levapren® vulcanizates are used for the French high-speed train TGV



Figure 26: Vitroflex® made of Levapren® (© ContiTech AG)

<sup>(1)</sup> Vitroflex® is a registered trademark of ContiTech Elastomer-Beschichtung GmbH  
\*\*See page 23

## Powermoon HeliMax®<sup>(1)</sup>

The properties mentioned before, in combination with the low gas permeability of Levapren®, make it an optimal choice for translucent materials such as the cover of the so-called Powermoon HeliMax® which, when filled with helium and lit up by strong halogen lights is used to illuminate big areas during the night. This has proven to be of great use for sports events, salvage work, etc.\*\*



Figure 27: Powermoon HeliMax® made of Levapren®

<sup>(1)</sup> Powermoon HeliMax® is a registered trademark of Jürgen Nölle, Rheinberg  
<sup>\*\*</sup>See page 23



**LEVAPREN®**

**RANGE & SUPPLY FORM**

Free flowing pellets  
– optimal dosing,  
good mixing behavior.

The numbers of the Levapren® nomenclature are used to differentiate the grades. The first two digits indicate the vinyl acetate content. Trial products are designated VP (VP = Versuchsprodukt in German). Some products are pre-crosslinked in a controlled manner in an additional process stage (XL grades). Levapren® is dispatched in 25-kg bags on pallets or in big bags. The bags are made from transparent PE and should always be removed if the compounding temperature does not significantly exceed their softening point.

Under suitable conditions (dry, max. temp. of 25 °C), Levapren® can be stored for 36 months from the date of manufacture. Higher temperatures or pressure may cause the granules to agglomerate, with the result that free-flowing properties cannot be guaranteed.

**Table 3: Product range and typical properties**

Product	Vinyl acetate content (%)	Mooney viscosity <sup>(1)</sup> ML (1+4) 100 °C	Density (g/cm <sup>3</sup> )	Physical form	Standard packaging	Remarks
Levapren® 400	40	20 ±4	0.98	granules	25 kg polyethylene bags** on pallet, 1000 kg net	used in cable manufacture and rubber goods
Levapren® 450	45	20 ±4	0.99			
Levapren® 500	50	27 ±4	1.00			
Levapren® 600	60	27 ±4	1.04			
Levapren® 650 VP*	65	27 ±4	1.06		25 kg polyethylene bags**	used in cable manufacture and rubber goods
Levapren® 700	70	27 ±4	1.08		in cardboard boxes on pallet, 1000 kg net	
Levapren® 800	80	28 ±6	1.11			
Levapren® 900	90	38 ±6	1.15			
<b>Trial products, precrosslinked</b>						
Levapren® 500 XL VP*	50	55 approx.	1.00	granules	25 kg polyethylene bags*** in cardboard boxes on pallet, contents : 750 kg	similar to Levapren® 500, 600, 700 and 800 with improved processing properties
Levapren® 600 XL VP*	60	55 approx.	1.04		25 kg polyethylene bags***	
Levapren® 700 XL VP*	70	60 approx.	1.08	in cardboard boxes on pallet, contents : 750 kg		
Levapren® 800 XL VP*	80	55 approx.	1.11	25 kg polyethylene bags***		
				granules in cardboard boxes on pallet, contents : 750 kg		

<sup>(1)</sup> unmassed (DIN 53523; ASTM D 1646)

\* Trial product (VP = Versuchsprodukt), please see page 23

\*\* Vicat A 93 °C, thickness 170 µm

\*\*\* Vicat A 100 °C, thickness 180 µm

## CONTACT DATA & SERVICE

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### Make use of our experience!

For direct information, please contact our technical support service. Our Levapren® experts look forward to answering your questions.

### Inventing the future together

Research and development plays a key role at LANXESS. The Technical Rubber Products Business Unit has research and technical centers with testing facilities on almost every continent. Whether you are looking for better compounding ideas or are thinking about developing a new product, our experts will be happy to assist you.



\* = Trial product

(VP = Versuchsprodukt = trial product). The information contained herein is merely preliminary data. Testing as to properties and applications is not final. Further information, including data which could change or add hazards with use, may be developed. Such information may be needed to properly evaluate or use this product. Use is undertaken at the sole risk of the user.

\*\* As with any product, use of the products mentioned in this publication in a given application must be tested (including field testing, etc.) by user in advance to determine suitability.

\*\*\* These items are provided as general information only. They are approximate values and are not considered part of the product specifications.

Product safety: Relevant safety data and references as well as the possibly necessary warning labels are to be found in the corresponding safety data sheets.

#### **Health and Safety Information:**

Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the LANXESS products mentioned in this publication. For materials mentioned which are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets and product labels. Consult your LANXESS representative in Germany or contact the Health, Safety, Environment and Quality Department (HSEQ) of LANXESS Germany or - for business in the USA - the LANXESS Product Safety and Regulatory Affairs Department in Pittsburgh, PA.

Regulatory Compliance Information: Some of the end uses of the products described in this publication must comply with applicable regulations, such as the FDA, BfR, NSF, USDA, and CPSC. If you have any questions on the regulatory status of these products, contact your LANXESS Corporation representative, the LANXESS Regulatory Affairs Manager in Pittsburgh, PA or the Health, Safety, Environment and Quality Department (HSEQ) of LANXESS Germany.

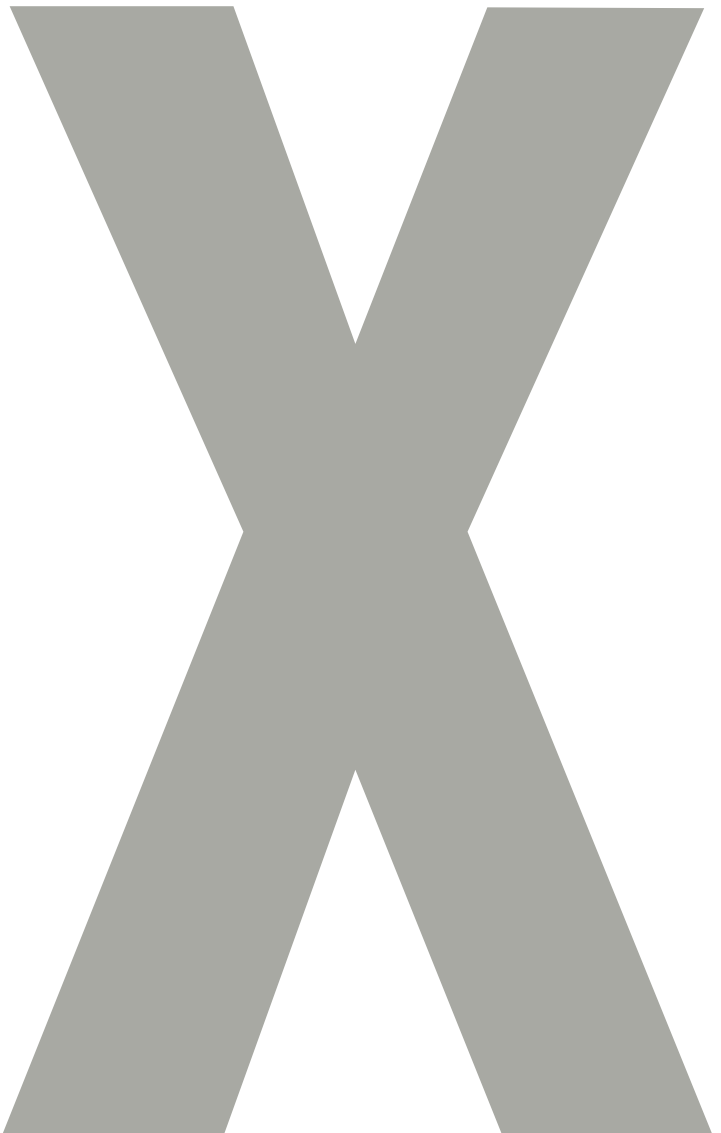
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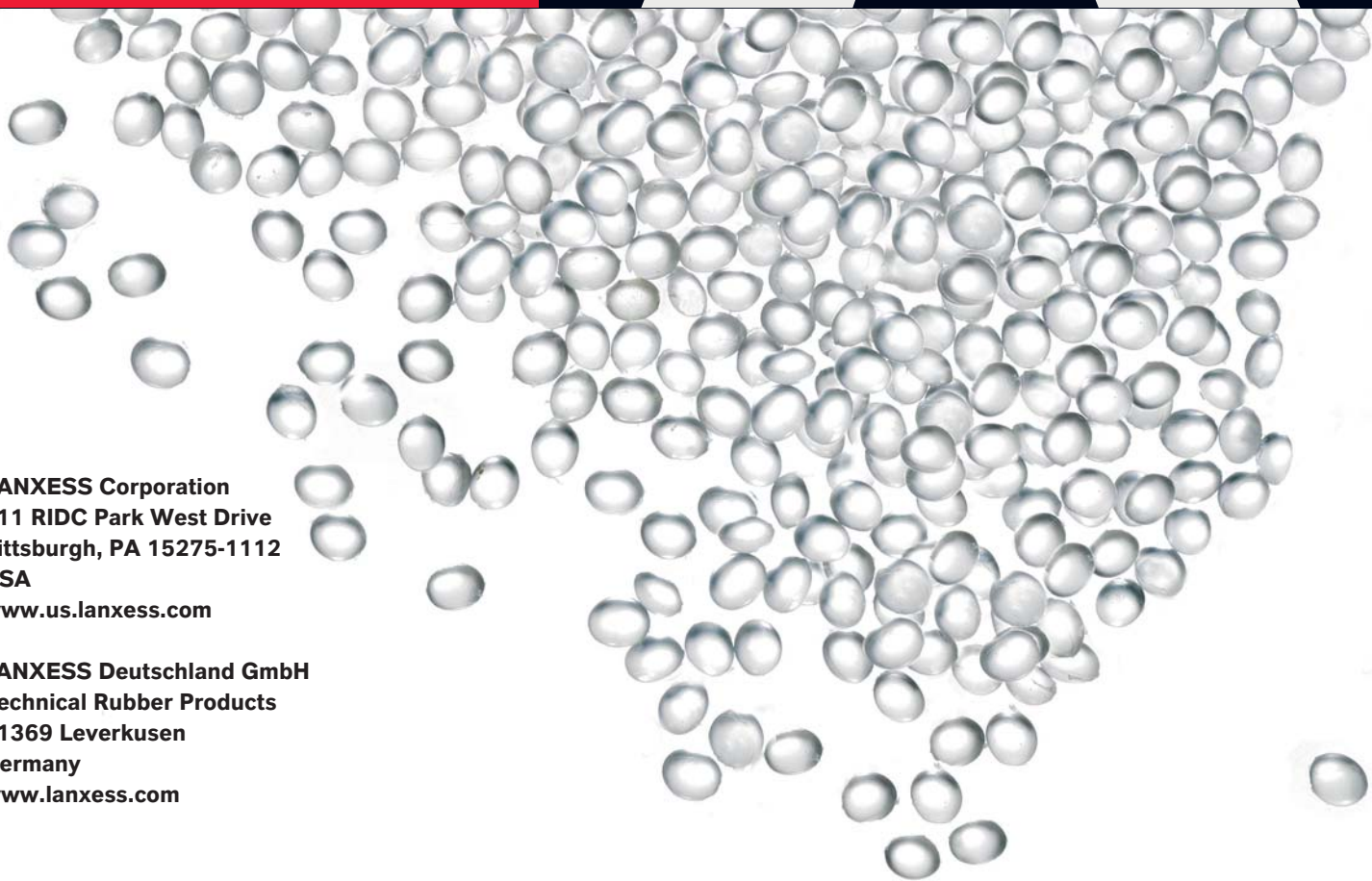


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